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(54) Title: METHOD AND APPARATUS FOR CUSTOMISING LOCATION AREA IN A COMMUNICATION NETWORK (57) Abstract The present invention relates to a method and an apparatus for providing each terminal (t ₁ , t ₂ , t) in a network (n) with an adapted location area (HA _{t1} , HA _{t2} , FA _s ?, FA _{pt}), customised to the long term or short term historical movements or behaviour of the terminal (t ₁ , t ₂ , t) in the network (n). The terminal (t ₁ , t ₂ , t) can enter three different modes; session mode, packet mode and transaction mode, which controls what kind of location area (HA _{t1} , HA _{t2} , FA _s , FA _{pt}) the terminal (t ₁ , t ₂ , t) should use. The types of location areas are a home location area (HA _{t1} , HA _{t2}), based on the long term historical movements of the terminal (t ₁ , t ₂ , t) and used when the terminal (t ₁ , t ₂ , t) is located inside a home area constituting the normal mobility pattern of the terminal in the network (n), a session mode-fast adaptive location area (FA _s), used when the terminal (t ₁ , t ₂ , t) enters the session mode and is located outside the home area, and a packet mode/transaction mode-fast adaptive location area (FA _{pt}), used for burstlike traffic when the terminal (t ₁ , t ₂ , t) enters the packet mode or the transaction mode.		

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METHOD AND APPARATUS FOR CUSTOMISING LOCATION AREA IN A COMMUNICATION NETWORK.

TECHNICAL FIELD OF THE INVENTION

The present invention relates to a method and an apparatus in a communication network for customising a location area for each radio mobile terminal in the network by continuously adapting
5 the size and the shape of the location area to that particular behaviour of the terminal in the network.

DESCRIPTION OF RELATED ART

According to prior art a communication network, also called network or cellular network, has to keep track of the movements
10 of a radio mobile terminal, also called terminal or mobile terminal, to be able to reach the terminal for incoming traffic to the terminal.

This means that when the terminal changes its location in the network it has to inform the network of its new location. This
15 is normally known as location updating or location registration.

A location area is defined as an area in which the terminal is able to move around without informing the network of its location. This reduces the number of location updates performed by the terminal as the terminal only has to inform the network
20 when the terminal changes location area.

The larger the location areas are, the fewer location updates are required by the terminal, but more base stations within the location area are involved when the terminal is paged in the network, and vice versa.

25 The network for example does paging of a terminal in the network when incoming calls to the terminal are to be set-up, whereby the terminal is paged in all cells belonging to the current location area of the terminal.

Periodic registration, also called periodic location updating,
30 is a way for the network to keep track of if a terminal is

leaving the coverage area of the network, or to keep track of if a terminal is shut down from the network without informing the network of this. Hereby, the network avoids to page terminals, which are not able to receive the page. Terminals in the network
5 informs the network of their position at predetermined time intervals, even if the terminal has not changed location area and hence the network gets a confirmation of that the terminal still is reachable in the network.

Generally, information that is sent between the terminal and a
10 corresponding basestation in the network comprise circuit switched traffic, like traditional phone calls, and packet data traffic consisting of information in packets.

A location area used for packet data traffic is smaller than a location area used for circuit switched traffic as packet
15 information more generally are sent often and in bursts, a small amount information every time. More location updates are performed by the terminal in the network as the location areas are small but the radio resources consumed by paging decreases with smaller location areas, since fewer basestations take part
20 in the page.

Existing networks today use location areas, which are static and the same for every terminal in the network. These location areas have fixed shapes and sizes, which are fairly adapted to fit an average behaviour of a user of a terminal in the network.

25 More advanced networks use overlapping location areas, for example in the mobile system PDC, which results in that different terminals in the network use different location areas. Still the overlapping location areas have fixed shapes and sizes.

30 A problem with this method is that the size of a location area will inevitably be a compromise between the needs of the different terminals in the network.

On research level adaptive methods are used that customise a location area for a specific terminal. Many of them define the location area as a list of cell identities.

5 A problem with this method is that a lot of data is transferred over the radio interface when the location area definitions are transferred from the network to the terminal.

In another method the cells are assumed to be equal in size and organised in a regular grid pattern. The size of the location area is defined as the number of cells the terminal can traverse
10 before it has to perform a location update in the network.

A problem with this method is that the cells are assumed to be equal in size and organised in a regular grid pattern, which can not be assumed in a real network.

In the patent document WO 94/13114 is disclosed a method for
15 performing location updating in a cellular radio system, wherein a location area is described which is dynamically adaptive and specific for each subscriber station.

A problem with this solution is that only the system is able to calculate location areas for the terminals in the network,
20 wherein needed information must be transferred from the system to the subscriber station every time the location area for a terminal is changed.

Another problem is that multiple location area identities must be broadcasted in every cell by the system, which is a waste of
25 radio resources in the system.

Further, the terminal is not used for collecting statistics or data, wherein the accuracy in the statistics, on which the adaptive location areas are based, may not be so good.

Another problem is that different location areas depending on
30 the type of traffic sent between the terminals and the system or depending on in which area of the network the terminals are

located is not used in this method, wherein the method is ineffective and not so flexible.

The patent document US 5, 590, 398 describes a virtual mobile location area (VMLA) personalised to the habits of a terminal, which location area employs predetermined grouping of cells arranged in order of likelihood that the terminal will be in the grouping. The historical pattern of the terminal is analysed and superimposed on the existing network to determine an optimum location area for the particular terminal.

10 A problem with this solution is that only the system is able to calculate location areas for the terminals in the network, wherein needed information must be transferred from the system to the terminal every time the location area for a terminal is changed.

15 A location update is performed when the terminal reaches a border of a location area, not at every contact between the network and the terminal, which results in that a contact with the network has to be done by the terminal with the only purpose to perform a location update.

20 Further, the terminal is not used for collecting statistics or data, wherein the accuracy in the statistics, on which the calculations of the location areas are based, may not be so good.

Another problem is that different location areas, depending on the type of traffic sent between the terminals and the system or depending on in which area of the network the terminals are located, is not used in this method, wherein the method is ineffective and not so flexible.

In the patent document WO 95/08902 is disclosed a method of registering a terminal in a cellular system in which cells form registration areas. Individual location areas are formed for one or more terminals with the intention of avoiding an

unnecessarily high number of registrations in border areas of the different registration areas. The location area for a given terminal has the form of a list of registration identities which list is transmitted to the terminal in conjunction with registration.

A problem with this solution is that the transferring of lists results in that a lot of data has to be sent at every registration, which in turn consumes valuable radio resources.

Another problem is that only the system is able to calculate location areas, wherein needed information must be transferred every time a location area is changed.

Further, different location areas depending on the type of traffic sent between the terminals and the system is not used in this method, wherein the method is ineffective and not so flexible.

SUMMARY OF THE INVENTION

The problem dealt with by the present invention is to minimise the radio resource consumption caused by paging, location updating and periodic registration of a radio mobile terminal, also called terminal or mobile terminal, in a communication network, also called network or cellular network.

Another problem is to distribute the load caused by location updating of the terminal in the network more evenly between cells in the network.

One intention of the invention is thus to minimise the radio resource consumption caused by paging, location updating and periodic registration of a terminal in the network.

Another intention is to distribute the load caused by location updating more evenly between cells in the network.

The problem is solved essentially by providing each terminal in a network with an adapted location area, customised to the long term or the short term historical movements or behaviour of the terminal in the network. The invention adapts algorithms, which
5 controls the shape, the position and the size of the location area, wherein the location area continuously adapts to the behaviour of the user of the terminal.

More specifically, the problem is solved in the following manner.

- 10 The terminal and the network use three different kinds of modes according to the invention. These modes in turn control what kind of location area the terminal should use. The different modes are called session mode, packet mode and transaction mode.

For a specific terminal in the network, the network uses a mode
15 corresponding to the same type of mode as used by the specific terminal.

The duration of the active periods of a communication, also called traffic, sent between the terminal and the corresponding basestation in the network and the duration of the silent
20 periods in between the active periods determines according to the invention what type of mode the terminal and the network should be in.

Three main types of location areas are used according to the invention. The first type of location area is a home location
25 area, which constitute the normal mobility pattern of the terminal in the network.

Algorithms based on the long term historical movements and traffic frequency of the terminal calculates, also called
30 creates below, a home location area for the terminal when the terminal logs on to the network, and this location area is thereafter transferred from the terminal to the network.

The calculated home location area is used by the terminal and the network when the terminal and the network are in the session mode and when the terminal is located within an home area, which constitute the normal mobility pattern of the terminal in the network (i.e. the home location area).

The second type of location area used by the invention is a session mode-fast adaptive location area. Algorithms simultaneously in both the terminal and the network calculate this location area when the terminal and the network enter the session mode and when the terminal is located outside the home area of the terminal (i.e. the latest calculated home location area).

The third type is a fast adaptive location area, which is used for burstlike traffic, like packet data traffic, which area is called a packet mode/transaction mode-fast adaptive location area.

The terminal and the network use the packet mode/transaction mode-fast adaptive location area when the terminal and the network are in the packet mode or the transaction mode, irrespective of where the terminal is located in the network. Algorithms simultaneously in both the terminal and the network calculate the packet mode/transaction mode-fast adaptive location area for the terminal.

The terminal and the network changes dynamically between the three different modes and adapts themselves to the present type of traffic, which as described above determines what type of location area the terminal should use in the network.

One advantage afforded by the invention is that it proposes a location area scheme, which minimises the consumption of radio resources caused by paging, location updating and periodic registration of the terminal in the network.

Another advantage is that the method according to the invention is very flexible and adaptable. The method can dynamically adapt to a variety of users as well as to future changes in communication styles and network usage habits without compromising the efficient usage of radio resources.

Still another advantage is that, since the location area borders can coincide with arbitrary cell borders, the location update load will not be concentrated to a few cells at the border of the location areas as is the case when fixed location areas are used.

Yet another advantage is that, in most cases, the location area can be changed without exchanging any data between the terminal and the network. This is a very radio resource efficient location update.

Still another advantage is that the method according to the invention simultaneously accommodates the different aspects and requirements of circuit switched traffic and packet data traffic. Users of both these basic communication modes will be efficiently handled according to the invention.

Yet another advantage is that no manual configuration is required to create, maintain and modify the location areas. The method is fully automated in that respect.

The invention will now be described in more detail with reference to exemplifying embodiments thereof and also with reference to the accompany drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic view of a communication network comprising different terminals and basestations, according to the invention,

Figure 2 is a schematic view of a home location area in the network adapted to a terminal according to the invention,

Figure 3a, 3b, 3c, 3d illustrates different shapes of fast adaptive location areas in the network according to the invention,

Figure 4a, 4b is a flowsheet illustrating a method according to the invention, and

Figure 5 is a block schematic illustrating a terminal according to the invention.

10 DETAILED DESCRIPTION OF THE EMBODIMENTS

Figure 1 shows a schematic view of a communication network n, also called network or cellular network, like for example GSM, NMT, and AMPS.

A number of basestations (BS₁-BS₉) are connected to the network n.

A first terminal t₁, also called terminal or mobile terminal, and a second terminal t₂ as shown in figure 1 can be used for communication in the network n. More terminals can exist in the network n than the two terminals t₁, t₂ shown in the figure.

In a first position pos1 shown in the figure the first terminal t₁ is located within a first home location area HA_{t1} adapted to the first terminal t₁ according to the invention in the network n, which is described in more detail below.

In the same way the first terminal t₁ is located in a first fast adaptive location area respective a second fast adaptive location area when the first terminal t₁ is in a second position pos2 respective a third position pos3 in the network n, which is described in more detail below.

In this example the second terminal t_2 is located within a second home location area HA_2 in the network n , as shown in figure 1.

Home location areas and fast adaptive location areas, adapted to a terminal t_1 , t_2 , are together called location areas below.

The network n is for example a universal network (GRAN, Generic Radio Access Network) described below, but the invention can be generalised to work in other networks too.

A universal network (GRAN, Generic Radio Access Network) is a network with a generic interface to which any type of service network (e.g. GSM, ISDN, PSTN) can connect. Users of the terminals subscribe to services in their respective service networks. The service networks use generic bearer services, offered by the universal network, to connect their users to the generic bearer services, thereby extending the ranges of their networks and providing mobility to their users.

This kind of universal network is described in Steinar Dahlin's patent application SE 9501497-3.

According to the invention each terminal t_1 , t_2 and the network n can be in either of three different modes: session mode, packet mode and transaction mode. The duration of the active periods of a communication, also called traffic, between the terminal t_1 , t_2 and the corresponding basestation BS_1 - BS_9 in the network n and the duration of the silent periods in between the active periods determines what type of mode the terminal t_1 , t_2 and the network n should use.

Two different ways of triggering a change of mode in the terminal t_1 , t_2 respective in the network n are thereby used according to the invention. One way is to measure the duration of an active period in a communication and another way is to measure the duration of a silent period in between two active periods in a communication, as mentioned above.

Types of traffic are for example circuit switched traffic, like traditional phone calls, and packet data traffic consisting of information in packets. Packet data traffic could be packet oriented, transaction oriented and session oriented.

5 Packet data traffic with packet oriented behaviour, also called packet oriented traffic, is in turn consisting of a single packet. Packet data traffic with transaction oriented behaviour, also called transaction oriented traffic, consists of several packets (e.g. constituting a client-server request-response
10 transaction) and packet data traffic with session oriented behaviour, also called session oriented traffic, consists of a complete application session.

Circuit switched traffic is often communication consisting of long lasting active periods and long lasting silent periods in
15 between the active periods, but it is theoretically possible for circuit switched traffic to consist of very short active periods too.

Packet oriented traffic is most likely to consist of very short lasting active periods and very short lasting silent periods in
20 between the active periods.

Transaction oriented traffic often consists of a little longer lasting active periods than the active periods for the packet oriented traffic, also called medium lasting active periods, with medium lasting silent periods in between the active
25 periods. Session oriented traffic in turn consists often of long lasting active periods.

The terminal t_1 , t_2 and the network n enter the session mode when the communication between the terminal t_1 , t_2 and the corresponding basestation BS_1 - BS_2 in the network n consists of a
30 long lasting active period. As an example the active period should have a time length ≥ 20 seconds.

The terminal t_1 , t_2 and the network n enter the packet mode when the communication consists of a very short lasting active period. As an example the active period should have a time length $\leq 2,5$ seconds.

- 5 When packet oriented communication is used, the packet mode is usually triggered in the terminal t_1 , t_2 and in the network n , as this type of communication often consists of very short lasting active periods.

10 The terminal t_1 , t_2 and the network n enter the transaction mode when the communication consists of a medium lasting active period with a time length within a specified window length. As an example the window length should be between 2,5 to 20 seconds.

15 When transaction oriented communication is used, the transaction mode is usually triggered in the terminal t_1 , t_2 and in the network n , as this type of communication often consists of medium lasting active periods.

20 The duration of a silent period is used to trigger a change of mode in the terminal t_1 , t_2 and in the network n when the current mode of the terminal t_1 , t_2 and the network n is not suitable for the current type of traffic existing between the terminal t_1 , t_2 and the network n .

25 In the packet mode, the communication between the terminal t_1 , t_2 and the corresponding basestation BS_1 - BS_2 in the network n is expected to consist of very short lasting active periods separated by very short lasting silent periods. If a too long duration of a silent period is detected in such a communication the packet mode is no longer suitable to use for the terminal t_1 , t_2 and the network n . A too long duration of a silent period
30 in this case is a duration exceeding a certain threshold value T_p .

In this case the terminal t_1 , t_2 and the network n enter the transaction mode. The transaction mode is entered as the absence of packets in the communication between the terminal t_1 , t_2 and the network n implies that the packets may have constituted a transaction, which is now finished, and therefore it is assumed that the current passive period is an interval between two transactions.

In the transaction mode, the communication between the terminal t_1 , t_2 and the corresponding basestation BS_1 - BS_9 in the network n is expected to consist of medium lasting active periods separated by medium lasting silent periods. If a too long duration of a silent period is detected in such a communication the transaction mode is no longer suitable to use for the terminal t_1 , t_2 and the network n . A too long duration of a silent period in this case is a duration exceeding a certain threshold value T_t .

In this case the terminal t_1 , t_2 and the network n enter the session mode. The session mode is entered as it is assumed that the transaction was part of a session, which is now finished, and therefore it is assumed that the current passive period is an interval between two sessions.

A terminal t_1 , t_2 and a network n , currently in the packet mode, can enter the session mode in case this mode seems more suitable to use depending on the duration of a silent period and the historical statistics of the silent periods in the communication between the terminal t_1 , t_2 and the network n .

Three main types of location areas are used according to the invention, which location areas are adapted to the behaviour of the terminal t_1 , t_2 . The first type of location area is a home location area HA_{t1} , HA_{t2} . The second type is a session mode-fast adaptive location area FA_s , and the third type is a packet mode/transaction mode-fast adaptive location area FA_{pt} .

The home location area concept of the invention is based on the assumption that most users of the terminals t_1 , t_2 have a fairly regular mobility pattern i.e. the users travel often between certain places. The home location area HA_{t1} , HA_{t2} is an area
5 which constitute the normal mobility pattern of the terminal t_1 , t_2 in the network n . This area is based on the long term historical movements of the terminal t_1 , t_2 , for example the past 100 days.

The invention uses a home location area HA_{t1} , HA_{t2} customised to
10 the terminal t_1 , t_2 when the terminal t_1 , t_2 and the network n use the session mode and when the terminal t_1 , t_2 is located within the area which constitute the normal mobility pattern of the terminal t_1 , t_2 in the network n . The creation of the home location area HA_{t1} , HA_{t2} is based on long term statistics, also
15 called data, of the terminal t_1 , t_2 which statistics are collected by the terminal t_1 , t_2 and stored in the terminal t_1 , t_2 . Examples of long term statistics of the terminal are incoming call frequency, outgoing call frequency, duration time per cell, and registered cell border crossings of the terminal
20 t_1 , t_2 .

The creation of the home location area HA_{t1} , HA_{t2} is done in the terminal t_1 , t_2 at each initial registration when the terminal t_1 , t_2 logs on to the network n . This can be when the terminal t_1 , t_2 is turned on or when it enters the coverage area of the
25 network n . The definition of the home location area HA_{t1} , HA_{t2} is then transferred from the terminal t_1 , t_2 to the network n .

If the terminal t_1 , t_2 remains logged on to the network n for a very long time, it is also possible to let the terminal t_1 , t_2 periodically calculate a new home location area and transfer the
30 definition of the new home location area to the network n . The creation of a home location area HA_{t1} , HA_{t2} according to the invention, adapted to the normal mobility pattern of the terminal t_1 , t_2 , is described below in association with figure 2.

Figure 2 shows a schematic view of the first terminal t_1 located in its home location area HA_{t_1} in the network n .

The work w of the user of the first terminal t_1 is located inside a first cell c_1 , the home h of the user of the first terminal t_1 is located inside a second cell c_2 . Stores s often visited by the user of the first terminal t_1 are located inside a third cell c_3 . Each cell c_1 - c_3 comprises a basestation BS connected to the network n .

The creation of the home location area HA_{t_1} of the first terminal t_1 is done by including cell borders in the location area, which cell borders are frequently crossed by the first terminal t_1 . These cell borders are for example the border of the cells c_1 - c_3 , which are often crossed by the first terminal t_1 , as shown in figure 2.

A border b of the home location area HA_{t_1} is built up by cell borders, which are less frequently crossed by the first terminal t_1 . Hereby the number of location updates between the first terminal t_1 and a corresponding basestation BS in a cell are kept low by placing the frequently crossed cell borders of the first terminal t_1 inside the home location area HA_{t_1} .

In this example according to figure 2 the home location area HA_{t_1} of the first terminal t_1 is created as an example. Of course the same method can be applied for the creation of a home location area belonging to the second terminal t_2 or other terminals located in the network n .

The algorithm used by the invention for creating a home location area HA_{t_1} uses as mentioned above long term statistics that the corresponding first terminal t_1 continuously records of its movements and pages. The statistics recorded by the first terminal t_1 for the calculation of the home location area HA_{t_1} are only recorded while the first terminal t_1 is in the session mode.

The first terminal t_1 comprise a non-volatile memory buffer, which contains recorded statistics from the latest period of time done by the first terminal t_1 . The length of this time is for example 100 days.

- 5 Each time the first terminal t_1 initially registrates to the network n (i.e. when it is powered on or when it enters the coverage area of the network n), the first terminal t_1 uses the long term statistics stored in the non-volatile memory buffer to calculate a suitable home location area HA_{t_1} consisting of
10 certain suitable cells. The first terminal t_1 then transfers the definition of the home location area HA_{t_1} to the network n .

- If the first terminal t_1 remains logged on to the network n for a very long time, it is also possible to let the first terminal t_1 periodically calculate a new home location area HA_{t_1} and
15 transfer the definition of the new home location area HA_{t_1} to the network n .

- The first terminal t_1 records the long term statistics according to the invention because the first terminal t_1 is able to record more detailed statistics about cell border crossings and cell
20 duration times than the network n is able to do. This is because the first terminal t_1 is constantly aware of the cell it is located in, while the network n only has this detailed information while it is in contact with the first terminal t_1 .

- In case the network n is a universal network described above,
25 the network n does not store any permanent subscriber or terminal related data. Hence the network n is not able to record any long term statistics for the terminals t_1 , t_2 in the network n . The most convenient way is therefore to let the terminal record the data.

- 30 The invention creates a session mode-fast adaptive location area FA_s customised to the terminal t_1 , t_2 in the case when the terminal t_1 , t_2 and the network n enter the session mode and

when the terminal t_1 , t_2 is located outside the area which constitute the normal mobility pattern of the terminal t_1 , t_2 in the network n (i.e. the latest calculated home location area).

5 The creation of the session mode-fast adaptive location area FA_s is based on short term statistics of the terminal t_1 , t_2 which statistics are collected and stored simultaneously by the terminal t_1 , t_2 and the network n at every contact between the terminal t_1 , t_2 and the network n .

10 According to the invention the session mode-fast adaptive location area FA_s is calculated in both the terminal t_1 , t_2 and the network n , using the same algorithm and the same input data to the algorithm for calculating the location area. A session mode-fast adaptive location area FA_s is always created so that the current position of the terminal t_1 , t_2 is located close to
15 the centre, or at least a significant distance from the border, of the session mode-fast adaptive location area FA_s .

The session mode-fast adaptive location area FA_s use as short term statistics the current and recent position, speed and movement direction of the terminal t_1 , t_2 in the network n . In
20 addition, the average frequencies of incoming and outgoing traffic to and from the terminal t_1 , t_2 are used in the calculations.

The basestation BS in each cell in the network n broadcasts the geographical co-ordinates that best represent the centre of the
25 cell and the position of the terminal t_1 , t_2 is set to be the geographical co-ordinates of the current cell in which the terminal t_1 , t_2 is located.

The speed of the terminal t_1 , t_2 is defined as the distance between the last two known positions of the terminal t_1 , t_2
30 divided by the time that has lapsed between these two position recordings.

The movement direction of the terminal t_1 , t_2 is derived according to the invention from the two or more last known positions of the terminal t_1 , t_2 .

5 Since the terminal t_1 , t_2 and the network n uses the same data for calculating a suitable session mode-fast adaptive location area FA_s , only the positions of the terminal t_1 , t_2 when it is in contact with the network n can be recorded and used by both the terminal t_1 , t_2 and the network n . Therefore the terminal t_1 , t_2 and the network n simultaneously record the time and the
10 geographical co-ordinates of the terminal t_1 , t_2 every time the terminal t_1 , t_2 is in contact with the network n , as mentioned above.

The terminal t_1 , t_2 is in contact with the network n for example when the terminal t_1 , t_2 initially registrates to the network n ,
15 every time the terminal t_1 , t_2 performs location updating, periodic registration to the network n or a handover, and every time an incoming or outgoing call is set-up to or from the terminal t_1 , t_2 , and subsequently when this call is released.

A new session mode-fast adaptive location area FA_s is calculated
20 at each of the above listed contacts, except at call set-up or handover, between the terminal t_1 , t_2 and the network n . A new session mode-fast adaptive location area FA_s for the terminal t_1 , t_2 is also calculated when the terminal t_1 , t_2 crosses the border of its current session mode-fast adaptive location area
25 FA_s .

At a call set-up and handover no new session mode-fast adaptive location area FA_s is calculated as there is an established communication between the terminal t_1 , t_2 and the network n , and no location area is therefore needed. Data is though recorded at
30 a call set-up and at handover, which data is to be used in later calculations of the session mode-fast adaptive location area FA_s .

The session mode-fast adaptive location areas FA_s , according to the invention reduces the load imposed by the terminal t_1, t_2 on the network n . This is achieved since in most cases a new session mode-fast adaptive location area FA_s can be calculated without transferring any data between the terminal t_1, t_2 and the network n for this purpose. Furthermore the terminal t_1, t_2 is always some distance from the border of the session mode-fast adaptive location area FA_s when the location area is created as the current position of the terminal t_1, t_2 is located close to the centre, or at least a significant distance from the border, of the created session mode-fast adaptive location area FA_s . Thereby repeated location updates caused by the terminal t_1, t_2 moving back and forth in the region of the location area border are avoided.

Another favourable property is that the session mode-fast adaptive location area FA_s for a stationary terminal quite soon shrink to a size including only the single cell where the terminal t_1, t_2 is located. This is because the speed of the terminal t_1, t_2 turns to zero, as described above, and this results in that the session mode-fast adaptive location area FA_s for the terminal comprise the co-ordinates of the position of the terminal, i.e. the geographical co-ordinates of the current cell in which the terminal t_1, t_2 is located.

The session mode-fast adaptive location area FA_s also distributes the location update load more evenly between the cells in the network n than is the case with fixed location areas, as in this case the location updating of a terminal in the network is concentrated to the cells located along the border of the corresponding fixed location area.

When the session mode-fast adaptive location area F_s is used according to the invention, the border of the location area can coincide with any cell border in the network. Furthermore, the border of the session mode-fast adaptive location area FA_s is different for different terminals in the network according to

the invention. Thereby the load imposed by a location update in the network is not concentrated to certain cells.

5 The algorithm used for calculating the session mode-fast adaptive location area FA_s in both the terminal t_1 , t_2 and in the network n uses, apart from the short term statistics described above, also focal points r_p , a generalised radius R_G and in some cases the local cell density. The focal points r_p and the generalised radius R_G are described in more detail below in association with figure 3a-3d.

10 As input data to the algorithm a chosen number of recent positions of the terminal t_1 , t_2 in the network n is used as well as the instant of time for the registration of these positions by the terminal t_1 , t_2 . The mentioned positions and the mentioned instant of times for the registration of these
15 positions are further used to calculate the average speed of the terminal t_1 , t_2 when the terminal t_1 , t_2 moved between two following registered positions of the terminal t_1 , t_2 in the network n . In addition, the average frequencies of incoming and outgoing traffic to and from the terminal t_1 , t_2 are used by the
20 algorithm.

As an option the local cell density, defined as the average number of cells per area unit in the vicinity of the present location of the terminal, can also be used as input data to the algorithm. In this case the algorithm will become more
25 effective, but it means that the network n must transfer the value of the cell density to the terminal t_1 , t_2 , which is a load on the radio resources in the network n . A fixed value of the cell density can as an alternative be used as input data to the algorithm, which fixed value is defined for the whole
30 network n and only needs to be transferred to the terminal t_1 , t_2 once. This transfer could for example take place when the terminal t_1 , t_2 logs on to the network n .

In case the local cell density is used as input data to the algorithm, the local cell density must be known by both the terminal t_1 , t_2 and the network n as mentioned above. Therefore the local cell density has to be conveyed by the network n to the terminal t_1 , t_2 either by broadcasting the density in every cell or by signalling the density during each contact between the terminal t_1 , t_2 and the network n , when a new session mode-fast adaptive location area FA_s should be calculated for the terminal t_1 , t_2 . In the latter case the local cell density only has to be signalled from the network n to the terminal t_1 , t_2 when it is different from what it was the last time a session mode-fast adaptive location area was calculated for the terminal t_1 , t_2 .

The focal points r_p and the generalised radius R_G are used as output data from the algorithm used by the session mode-fast adaptive location area FA_s . Together they define the shape, the position and the size of the session mode-fast adaptive location area FA_s for the terminal t_1 , t_2 .

The generalised radius R_G represents the size of the session mode-fast adaptive location area FA_s and the distribution of the focal points r_p represents the shape and the position of the session mode-fast adaptive location area FA_s . Specifically, the relative positions of the focal points r_p define the shape of the session mode-fast adaptive location area FA_s and their absolute positions define the position of the session mode-fast adaptive location area FA_s .

The relative positions of the focal points r_p are calculated by using a chosen number of recent positions of the terminal t_1 , t_2 in the network n as well as the average speed of the terminal t_1 , t_2 during the movement of the terminal t_1 , t_2 between these positions. The distance between the focal points r_p is scaled up or down thereafter depending on the value of the calculated generalised radius R_G . The scaling of the distance between the focal points r_p is done to maintain the shape of the location

area irrespective of what the calculated generalised radius R_G turns out to be.

The generalised radius R_G is defined as the sum of the distances from a point $r(\text{borderline})$ at a border b_2 of the session mode-fast adaptive location area FA_s to each of the focal points r_p inside this area FA_s as shown in the figures.

Equation 1 below describes a formula for defining the generalised radius R_G of the session mode-fast adaptive location area FA_s comprising a number n_{FP} of focal points r_p :

10 Equation 1: The generalised radius $R_G = \sum_{i=0}^{n_{FP}-1} | r(\text{borderline}) - r_{pi} |$

15 Figure 3a shows a schematic view of the session mode-fast adaptive location area FA_s comprising one focal point r_{p0} located at a distance A from a point $r(\text{borderline})$ at the border b_2 . The number of focal points n_{FP} is equal to 1 and the session mode-fast adaptive location area FA_s is therefore a circle with the generalised radius $R_G=A$ according to equation 1.

20 Figure 3b shows a schematic view of the session mode-fast adaptive location area FA_s comprising two focal points r_{p0} , r_{p1} located at a distance A respective B from a point $r(\text{borderline})$ at the border b_2 . The number of focal points n_{FP} is equal to 2 and the session mode-fast adaptive location area FA_s is therefore an ellipse with the generalised radius $R_G=A+B$ according to equation 1.

30 Figure 3c shows a schematic view of the session mode-fast adaptive location area FA_s comprising three focal points r_{p0} , r_{p1} , r_{p2} located at a distance A , B respective C from a point $r(\text{borderline})$ at the border b_2 . The number of focal points n_{FP} is equal to 3 and the session mode-fast adaptive location area FA_s

has therefore an irregular shape with the generalised radius $R_G = A+B+C$ according to equation 1.

A point $r(\text{area})$ lying inside the session mode-fast adaptive location area FA_s satisfies according to equation 1 the following relation 2:

Relation 2: The generalised radius $R_G \geq \sum_{i=0}^{n_{FP}-1} |r(\text{area}) - r_{pi}|$

Figure 3d shows a schematic view of the first terminal t_1 located in a current session mode-fast adaptive location area FA_{t1} . The current session mode-fast adaptive location area FA_{t1} in this example comprise three focal points r_{p00} , r_{p11} , r_{p22} located at a distance A_1 , B_1 respective C_1 from a border point r_{b1} . The border point r_{b1} is a point on a border b_1 of the current session mode-fast adaptive location area FA_{t1} .

When the first terminal t_1 wants to determine whether it has reached the border of the current session mode-fast adaptive location area FA_{t1} or not, the first terminal t_1 checks whether the geographical co-ordinates of its current cell satisfies relation 2.

If the geographical co-ordinates of the current cell of the first terminal t_1 satisfy relation 2 then the first terminal t_1 is still in the current session mode-fast adaptive location area FA_{t1} . Otherwise the first terminal t_1 has left the current session mode-fast adaptive location area FA_{t1} and a new session mode-fast adaptive location area has to be calculated for the terminal t_1 .

In the case when the terminal t_1 , t_2 and the network n enter the packet mode or the transaction mode, the invention creates a fast adaptive location area customised to the terminal t_1 , t_2 , irrespective of where the terminal t_1 , t_2 is located in the

network n . This fast adaptive location area is called a packet mode/transaction mode-fast adaptive location area FA_{pt} .

5 The packet mode/transaction mode-fast adaptive location area FA_{pt} is a continuously changing location area, which is triggered by an active period of a certain length and then grows continuously as a function of the time during the subsequent silent period in a communication between the terminal t_1 , t_2 and the network n .

10 The packet mode-fast adaptive location area and the transaction mode-fast adaptive location area are of the same type, i.e. they use the same algorithms. The difference between them is that they use different values of the parameters in the algorithms.

15 According to the invention the packet mode/transaction mode-fast adaptive location area FA_{pt} is calculated in both the terminal t_1 , t_2 and the network n , using the same algorithm and the same input data to the algorithm for calculating the packet mode/transaction mode-fast adaptive location area. A packet mode/transaction mode-fast adaptive location area FA_{pt} is always created so that the current position of the terminal t_1 , t_2 is located close to the centre, or at least a significant distance from the border, of the packet mode/transaction mode-fast adaptive location area FA_{pt} .

25 The creation of the packet mode/transaction mode-fast adaptive location area FA_{pt} is based on short term statistics of the terminal t_1 , t_2 , which statistics are collected and stored simultaneously by the terminal t_1 , t_2 and the network n at every contact between the terminal t_1 , t_2 and the network n , as well as focal points r_p and a generalised radius R_G .

30 The packet mode/transaction mode-fast adaptive location area FA_{pt} use as short term statistics for example the current and recent position, speed and movement direction of the terminal t_1 , t_2 in the network n , as well as statistics of the length of

the silent periods between the active periods in the communication between the terminal t_1 , t_2 and the network n . These statistics are constantly collected and the statistics from the latest period of time are always used when calculating the packet mode/transaction mode-fast adaptive location area FA_{pt} .

The time duration since the last active communication period is used by the terminal t_1 , t_2 and the network n to calculate the generalised radius R_G as a function of the time is also used, as described below.

The algorithm used for calculating the packet mode/transaction mode-fast adaptive location area FA_{pt} in both the terminal and in the network use as input data statistics of the length of the silent periods between the active periods in the communication between the terminal t_1 , t_2 and the network n , as well as the input data used in the algorithm for calculating a session mode-fast adaptive location area FA_s (except the average frequencies for incoming and outgoing traffic to and from the terminal t_1 , t_2).

The focal points r_p and the generalised radius R_G are used as output data from the algorithm used by the packet mode/transaction mode-fast adaptive location area FA_{pt} . Together they define the shape, the position and the size of the session mode-fast adaptive location area FA_s for the terminal t_1 , t_2 . The generalised radius R_G represents the size of the packet mode/transaction mode-fast adaptive location area FA_{pt} and is a function of the time, as described below.

The distribution of the focal points r_p represents the shape and the position of the packet mode/transaction mode-fast adaptive location area FA_{pt} . Specifically, the relative positions of the focal points r_p define the shape of the packet mode/transaction mode-fast adaptive location area FA_{pt} and their absolute

positions define the position of the packet mode/transaction mode-fast adaptive location area FA_{pt} .

5 The same algorithms for the distribution of the focal points r_p are used when calculating the packet mode/transaction mode-fast adaptive location area FA_{pt} as for the session mode-fast adaptive location area FA_s described above.

10 The calculation of the generalised radius R_G uses a different algorithm when the terminal t_1 , t_2 and the network n has entered the packet mode or the transaction mode than the session mode-fast adaptive location area FA_s . The optimal generalised radius for the session mode-fast adaptive location area FA_s is calculated by expressing the expected paging load, the location updating load and the periodic registration load as functions of the generalised radius. Thereafter is calculated at what
15 generalised radius the sum of these functions has its minimum.

The same principle is used when calculating the optimal generalised radius for the packet mode/transaction mode-fast adaptive location area FA_{pt} , but a parameter concerning the time duration since the last active communication period is also
20 used. It is suitable in this case to let the packet mode/transaction mode-fast adaptive location area FA_{pt} grow the longer a silent period in a communication between the terminal t_1 , t_2 and the network becomes.

It is just the size of the packet mode/transaction mode-fast adaptive location area FA_{pt} that is changing with the time as
25 the generalised radius R_G changes with the time. The shape and the position of the packet mode/transaction mode-fast adaptive location area FA_{pt} is not changing with time, only at every contact between the terminal t_1 , t_2 and the network n as a new
30 packet mode/transaction mode-fast adaptive location area FA_{pt} is created then.

As the size of the packet mode/transaction mode-fast adaptive location area FA_{pt} is changing with the time, the terminal t_1, t_2 needs to calculate the momentary size of the packet mode/transaction mode-fast adaptive location area FA_{pt} every
5 time the terminal t_1, t_2 enters a new cell in the network n , in order to determine whether the new cell is located inside or outside the current location area.

Further the network n needs to calculate the momentary packet mode/transaction mode-fast adaptive location area FA_{pt} every
10 time the terminal t_1, t_2 has to be paged by the network n , so that the cells belonging to the current location area of the terminal t_1, t_2 , and in which cells the terminal t_1, t_2 thus has to be paged, can be identified by the network n .

The first reason for the different calculations of the
15 generalised radius R_G for the session mode-fast adaptive location area FA_s and the packet mode/transaction mode-fast adaptive location area FA_{pt} is that the algorithm for the session mode-fast adaptive location area FA_s uses a call frequency, which is a constant representing an average of the
20 actual call frequency.

Short lasting active periods in a communication or little longer lasting active periods in a communication, as is the case for the packet mode or the transaction mode, arrive in bursts followed by long intervals and therefore the call frequency must
25 for the packet mode/transaction mode-fast adaptive location area FA_{pt} reflect the higher traffic intensity within the bursts and the lower traffic intensity in between the bursts in this case.

The second reason is that the algorithm for calculating the session mode-fast adaptive location area FA_s is based on a
30 Poisson distributed model. The Poisson model is not applicable to information in packets, as is the case for calculation of the packet mode/transaction mode-fast adaptive location area FA_{pt} .

The terminal t_1 , t_2 and the network n changes dynamically between the different modes and adapts themselves to the present type of traffic sent between the terminal t_1 , t_2 and the corresponding basestation BS_1 - BS_9 in the network n , which as described above
5 determines what type of location area HA_{t1} , HA_{t2} , FA_{t1} , FA_s , FA_{pt} the terminal t_1 , t_2 should use. A default mode is assumed to be used according to the invention, for example the session mode, when the terminal t_1 , t_2 logs on to the network n .

In a special case according to the invention, the terminal t_1 ,
10 t_2 and the network n enter the session mode if the generalised radius R_G for the packet mode/transaction mode-fast adaptive location area FA_{pt} for the terminal t_1 , t_2 , which has entered the packet mode or the transaction mode, would at any point in time exceed a generalised radius R_{Gs} . The generalised radius R_{Gs}
15 corresponds to the generalised radius for the session mode-fast adaptive location area FA_s for the terminal t_1 , t_2 in the session mode as calculated at the last contact between the terminal t_1 , t_2 and the network n as if the terminal t_1 , t_2 had then been in the session mode.

20 In the following example is described a method according to the invention in association with figure 1, 4a, 4b and the above examples.

Figure 4a and 4b illustrates a flowsheet of a method according to the invention. The method is described for the first terminal
25 t_1 as an example, and of course the same method can be applied to the second terminal t_2 or other terminals located in the network n .

It is assumed in the following example that the first terminal t_1 is in an initial state located at the first position $pos1$ in
30 figure 1 and the first terminal t_1 (and the network n) enters the session mode when the first terminal t_1 logs on to the network n .

For the first terminal t_1 in the network n , the network n uses a mode corresponding to the same type of mode as used by the first terminal t_1 .

5 The method begins with that the user of the first terminal t_1 in step 101 in figure 4a logs on the first terminal t_1 to the network n by for example pushing a button on the first terminal t_1 . The first terminal t_1 (and the network n) then automatically enters the session mode in step 103.

10 In the next step 105 the first terminal t_1 starts with creating, according to the algorithm described above, a home location area HA_{t_1} adapted to the long term movements of the first terminal t_1 .

The calculated home location area HA_{t_1} in the first terminal t_1 is in step 107 transferred to the network n .

15 The first terminal t_1 (and the network n) continues in step 109 to establish the duration of the current active period that is existing in a communication between the first terminal t_1 and the network n .

20 The first terminal t_1 (and the network n) establishes in this example a communication with a long lasting active period, which for example could be a circuit switched communication. This communication is also called a long lasting communication below. Therefore the first terminal t_1 (and the network n) in step 111 still is triggered to be in the session mode.

25 In the next step 113 the first terminal t_1 according to the invention establishes whether the geographical position of the first terminal t_1 is inside an home area constituting the normal mobility pattern of the movements of the first terminal t_1 , based on long term statistics of the movements of the first terminal t_1 .

30 In this example the first terminal t_1 is assumed to be located at the first position pos_1 in figure 1 and therefore located

inside the home area. The first terminal t_1 then in step 115, as well as the network n , uses the home location area HA_{t_1} created in step 105 as the location area for the first terminal t_1 .

5 In the case where the first terminal t_1 is assumed to be located at the second position pos2 in figure 1, then the first terminal t_1 is not located inside the home area (i.e. the latest calculated home location area) and therefore both the first terminal t_1 and the network n in step 119 calculates a session mode-fast adaptive location area FA_s adapted to the short term
10 movements of the terminal t_1 .

When the first terminal t_1 in step 121 has contact with the network n , a new session mode-fast adaptive location area is calculated in both the first terminal t_1 and the network n in case the first terminal t_1 still is located outside the home
15 area, according to step 113, and the communication between the first terminal t_1 and the network n still is long lasting, according to step 117. The mentioned contact does not include call set-ups or handovers, as there is an established communication between the first terminal t_1 and the network n
20 and therefore no location area is needed in these cases. Data is though recorded at call set-ups and at handovers, which data is to be used in later calculations of the session mode-fast adaptive location area FA_s .

Similarly in the next step 123, when the first terminal t_1 has
25 reached the border of the current session mode-fast adaptive location area FA_s , a new session mode-fast adaptive location area is calculated in both the first terminal t_1 and the network n in case the first terminal t_1 still is located outside the home area, according to step 113. The first terminal t_1 has left
30 the current session mode-fast adaptive location area FA_s , according to step 123, in case the geographical co-ordinates of the current cell, in which the first terminal t_1 is located, does not satisfy relation 2 described above.

Now it is assumed that the communication between the first terminal t_1 and the network n switches to send very short lasting active periods, which for example could be a packet oriented communication. This communication is also called a very short lasting communication. The first terminal t_1 is assumed to be located at the third position $pos3$ in figure 1, inside the home area of the first terminal t_1 .

The first terminal t_1 (and the network n) then after step 117, marked with the notation C_4 in figure 4a, establishes the duration of the current active period in the communication in step 109 to be very short lasting, and therefore the first terminal t_1 (and the network n) according to the invention enters the packet mode in step 125.

In this mode a packet mode/transaction mode-fast adaptive location area FA_{pt} is created simultaneously in the first terminal t_1 and the network n for the first terminal t_1 in step 129, adapted to the first terminal t_1 as described in the above examples.

The packet mode/transaction mode-fast adaptive location area FA_{pt} is created for the first terminal t_1 irrespective of the position of the first terminal t_1 in the network n .

In case the first terminal t_1 in step 131 enters a new cell in the network n , a momentary packet mode/transaction mode-fast adaptive location area FA_{pt} is calculated for the first terminal t_1 in step 134, as described above.

Every time the first terminal t_1 is in contact with the network n in step 145, as marked with the notation C_1 in figure 4a and 4b, a new packet mode/transaction mode-fast adaptive location area FA_{pt} is created for the first terminal t_1 in step 129 in case the communication between the first terminal t_1 and the network n still is very short lasting, according to step 147. This is marked in figure 4a and 4b with the notation C_6 .

In case the communication between the first terminal t_1 and the network n is not very short lasting according to step 147, the method continuous to step 109 as marked with the notation C_4 in figure 4a and 4b. The terminal t_1 (and the network n) enters
5 thereby a new suitable mode depending on the duration of the current active period in the communication.

If the duration of a current silent period in the communication between the terminal t_1 and the network n in the next step 151 exceeds the threshold value T_p as described above, then the
10 first terminal t_1 (and the network n) enters the transaction mode according to step 127. This is marked with the notation C_5 in figure 4a and 4b.

Otherwise the first terminal continues to step 152 to check whether it has crossed the border of the packet mode/transaction
15 mode-fast adaptive location area. If this is the case a new packet mode/transaction mode-fast adaptive location area is created according to step 129. This is marked with the notation C_6 in Figure 4a and 4b. Otherwise the first terminal t_1 continues to step 131 to check whether the terminal t_1 has
20 entered a new cell. This is marked with the notation A_3 in figure 4a and 4b.

In another example according to the invention the communication between the first terminal t_1 and the network n consists of active periods with a time length within a specified window
25 length as described above, which for example could be a transaction oriented communication. This communication is also called a medium lasting communication. The first terminal t_1 (and the network n) in the above described example in step 109 establishes the duration of an active period in the
30 communication to be medium lasting. Therefore the first terminal t_1 (and the network n) in step 127 enters the transaction mode.

The terminal t_1 continues in step 129 to create a packet mode/transaction mode-fast adaptive location area FA_{pt} . This

kind of location area is described above when the first terminal t_1 has entered the packet mode. The procedure for the first terminal t_1 follows the above described steps 131-134.

5 The duration of a current active period in the communication between the first terminal t_1 and the network n is checked in step 155 every time the first terminal t_1 is in contact with the network n in step 153. This is marked in figure 4a and 4b with the notation C_2 .

10 In case the communication between the first terminal t_1 and the network n still is medium lasting, according to step 155, a new packet mode/transaction mode-fast adaptive location area FA_{pt} is created for the first terminal t_1 in step 129. This is marked in figure 4a and 4b with the notation C_6 .

15 Otherwise, if the communication between the first terminal t_1 and the network n is not medium lasting according to step 155, the method continuous to step 109 as marked with the notation C_4 in figure 4a and 4b. The terminal t_1 (and the network n) enters thereby a new suitable mode depending on the duration of the current active period in the communication.

20 The duration of a current silent period in the communication between the terminal t_1 and the network n is checked in the next step 159. If this duration exceeds the threshold value T_t as described above, then the first terminal t_1 (and the network n) enters the session mode according to step 111. This is marked
25 with the notation C_3 in figure 4a and 4b.

Otherwise the first terminal t_1 continues to step 160 to check whether it has crossed the border of the packet mode/transaction mode-fast adaptive location area. If this is the case a new packet mode/transaction mode-fast adaptive location area is
30 created according to step 129. This is marked with the notation C_6 in Figure 4a and 4b. Otherwise the first terminal t_1 continues to step 131 to check whether the first terminal t_1 has

entered a new cell. This is marked with the notation A_3 in figure 4a and 4b.

Figure 5 depicts a block schematic of a terminal t according to the invention as described above.

5 The terminal t comprise as an example a receiver 303, a transmitter 305, an input unit 307, a timer unit 309, a keyset 311 including a power on/off button 312, a measuring unit 313, a non-volatile memory 315, a calculating unit 317, and a control unit 319, which are the components shown in figure 5. The
10 receiver 303 and the transmitter 305 are connected to an antenna 301. All the units are connected to each other by a databus 321 as shown in the figure.

The user of the terminal t logs on the terminal t to the network n by pushing the power on button 312 on the keyset 311 on the
15 terminal t , wherein the input unit 307 registrates this and the terminal t enters for example the session mode according to the method described above.

The timer unit 309 in the terminal t is used for example to trigger the terminal t to enter the session mode or the
20 transaction mode as described above if the duration of a current silent period in a communication exceeds a certain threshold value T_p or T_t .

The measuring unit 313 is used by the terminal t for distinguishing the information in a communication between the
25 terminal t and the network n . The measuring unit 313 measures the duration of a current active period in the communication between the terminal t and the network n and the duration of a current silent period in between two active periods. Long lasting communications triggers the terminal t to enter the
30 session mode, medium lasting communications triggers the terminal t to enter the transaction mode and very short lasting

communications triggers the terminal t to enter the packet mode as described in the above example.

5 The non-volatile memory 315 in the terminal t is used for storing the above mentioned recorded statistics, also called data, from the latest period of time done by the terminal t, which data is used later in time by the calculating unit 317 for calculating a suitable location area.

10 The calculating unit 317 calculates suitable location areas for the terminal t in the network according to the examples described above.

15 The units 303, 305, 307, 309, 311, 312, 313, 315, 317 and 319 in the terminal t are connected to the databus 321, through which the units communicate with each other. The control unit 319 in the terminal t controls the different units via the data bus 321 and affects them to perform wanted operations according to the invention.

20 The invention described above may be embodied in yet other specific forms without departing from the spirit or essential characteristics thereof. Thus, the present embodiments are to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing descriptions, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

CLAIMS

1. Method in a communication network (n) comprising cells (C₁-C₃), basestations (BS₁-BS₉) and at least one terminal (t₁, t₂, t) for adapting a location area to the terminal (t₁, t₂, t),
5 wherein the method include the following steps:
- to log on the terminal (t₁, t₂, t) to the network (n);
- to create a long term adapted location area (HA_{t1}, HA_{t2}), adapted to the long term mobility pattern of a user of the terminal (t₁, t₂, t) in the network (n);
- 10 to determine a type of communication between the terminal (t₁, t₂, t) and the network (n);
- to enter the terminal (t₁, t₂, t) and the network (n) in a mode corresponding to the mentioned determined communication type, wherein the different modes for the terminal (t₁, t₂, t) and the
15 network (n) to enter are session mode, packet mode and transaction mode;
- to use the long term adapted location area (HA_{t1}, HA_{t2}) when the terminal (t₁, t₂, t) is located in a home area of the terminal (t₁, t₂, t) and when the terminal (t₁, t₂, t) and the network (n)
20 enter the session mode;
- to create a short term adapted session-location area (FA_s) when the terminal (t₁, t₂, t) is located outside the home area of the terminal (t₁, t₂, t) and when the terminal (t₁, t₂, t) and the network (n) enter the session mode; and
- 25 to create a short term adapted packet/transaction-location area (FA_{pt}) when the terminal (t₁, t₂, t) and the network (n) enter the packet mode or the transaction mode.
2. Method according to claim 1, wherein the method includes the step to enter the terminal (t₁, t₂, t) and the network (n) in an

initial mode when the terminal (t_1 , t_2 , t) logs on to the network (n).

3. Method according to claim 2, wherein the method includes the step to set the initial mode to be the session mode.

5 4. Method according to claim 2 or 3, wherein the method includes the step to base the long term adapted location area (HA_{t1} , HA_{t2}) on statistics continuously collected and stored by the terminal (t_1 , t_2 , t) in the network (n), which long term adapted location area (HA_{t1} , HA_{t2}) is created by the terminal (t_1 , t_2 , t) and
10 transferred to the network (n) at the initial contact between the terminal (t_1 , t_2 , t) and the network (n), when the terminal (t_1 , t_2 , t) logs on to the network (n).

5. Method according to claim 4, wherein the method includes the step to let the terminal (t_1 , t_2 , t) periodically create a new
15 long term adapted location area (HA_{t1} , HA_{t2}) and transfer the definition of the mentioned new long term adapted location area (HA_{t1} , HA_{t2}) to the network (n) if the terminal (t_1 , t_2 , t) remains logged on to the network (n) for a long time.

6. Method according to claim 4 or 5, wherein the method includes
20 the step to measure the duration of the active periods in the communication between the terminal (t_1 , t_2 , t) and the network (n) and the duration of the silent periods in between these active periods to determine the type of communication.

7. Method according to claim 6, wherein the method includes the
25 step to enter the terminal (t_1 , t_2 , t) and the network (n) in the session mode when the duration of an active period in the communication between the terminal (t_1 , t_2 , t) and the network (n) is long lasting.

8. Method according to claim 7, wherein the method includes the
30 step to enter the terminal (t_1 , t_2 , t) and the network (n) in the packet mode when the duration of an active period in the

communication between the terminal (t_1 , t_2 , t) and the network (n) is very short lasting.

9. Method according to claim 8, wherein the method includes the step to enter the terminal (t_1 , t_2 , t) and the network (n) in the transaction mode when the duration of an active period in the communication between the terminal (t_1 , t_2 , t) and the network (n) is medium lasting.

10. Method according to claim 8, wherein the method includes the step to enter the terminal (t_1 , t_2 , t) and the network (n) in the transaction mode when the duration of a silent period in the communication between the terminal (t_1 , t_2 , t) and the network (n) exceeds a threshold value (T_p).

11. Method according to claim 9, wherein the method includes the step to enter the terminal (t_1 , t_2 , t) and the network (n) in the session mode when the duration of a silent period in the communication between the terminal (t_1 , t_2 , t) and the network (n) exceeds a threshold value (T_t).

12. Method according to claim 6, 7, 8, 9, 10 or 11, wherein the method includes the step to simultaneously collect and store data in the terminal (t_1 , t_2 , t) and in the network (n) at every contact between the terminal (t_1 , t_2 , t) and the network (n), wherein the data comprise information about the position of the terminal (t_1 , t_2 , t) in the network (n), the speed of the terminal (t_1 , t_2 , t) and the direction of the terminal (t_1 , t_2 , t) in the network (n).

13. Method according to claim 12, wherein the method includes the step to create a new short term adapted session-location area (FA_s) by the terminal (t_1 , t_2 , t) and the network (n) at every contact between the terminal (t_1 , t_2 , t) and the network (n) or when the terminal (t_1 , t_2 , t) reaches a border of a current short term adapted session-location area (FA_s), if the

terminal (t_1 , t_2 , t) is located in the current short term adapted session-location area (FA_s).

14. Method according to claim 12, wherein the method includes the steps to create a new short term adapted packet/transaction-location area (FA_{pt}) by the terminal (t_1 , t_2 , t) and the network (n) at every contact between the terminal (t_1 , t_2 , t) and the network (n) if the terminal (t_1 , t_2 , t) is located in a current short term adapted packet/transaction-location area (FA_{pt}), and to use a momentary short term adapted packet/transaction-location area (FA_{pt}) by the terminal (t_1 , t_2 , t) when the terminal (t_1 , t_2 , t) enters a new cell in the network (n) or by the network (n) when the network (n) has to page the terminal (t_1 , t_2 , t) in the network (n), if the terminal (t_1 , t_2 , t) is located in the current short term adapted packet/transaction-location area (FA_{pt}).

15. Method according to claim 13 or 14, wherein the creation of the short term adapted session-location area (FA_s) and the short term adapted packet/transaction-location area (FA_{pt}) uses a radius (R_G) and focal points (r_p), wherein the radius (R_G) determine the size of the mentioned location areas and the focal points (r_p) determine the shape and the position of the mentioned location areas.

16. Method according to claim 15, wherein the short term adapted session-location area (FA_s) and the short term adapted packet/transaction-location area (FA_{pt}) are created without any transfer of data between the terminal (t_1 , t_2 , t) and the network (n).

17. Method according to claim 16, wherein the short term adapted packet/transaction-location area (FA_{pt}) changes continuously with time.

18. Method according to any of the claims 1-17, wherein the method includes the step to let the home area be an area

constituting the normal mobility pattern of the movements of the terminal (t_1 , t_2 , t) in the network (n) based on long term statistics of the movements of the terminal (t_1 , t_2 , t) in the network (n).

- 5 19. Method according to any of the claims 1-18, wherein the method includes the step to let the network (n) be a universal network (GRAN, Generic Radio Access Network).

- 10 20. Method in a communication network (n) comprising cells (C_1 - C_3), basestations (BS_1 - BS_9) and at least one terminal (t_1 , t_2 , t), being able to communicate with the network (n) with a type of communication, for adapting a location area to the terminal (t_1 , t_2 , t), wherein the method creates a location area for the terminal (t_1 , t_2 , t) depending on the type of communication, between the terminal (t_1 , t_2 , t) and the network (n).

- 15 21. Method according to claim 20, wherein the location area for the terminal (t_1 , t_2 , t) is dependent on the position of the terminal (t_1 , t_2 , t) in the network (n).

22. Method according to claim 21, wherein the method includes the steps:

- 20 to create a long term adapted location area (HA_{t1} , HA_{t2}), adapted to the long term mobility pattern of a user of the terminal (t_1 , t_2 , t) in the network (n), when the terminal (t_1 , t_2 , t) is located in a home area of the terminal (t_1 , t_2 , t) and when the terminal (t_1 , t_2 , t) and the network (n) enter a session mode;
25 and

to create a short term adapted session-location area (FA_s) when the terminal (t_1 , t_2 , t) is located outside the home area of the terminal (t_1 , t_2 , t) and when the terminal (t_1 , t_2 , t) and the network (n) enter the session mode.

- 30 23. Method according to claim 20, wherein the method includes the step to create a short term adapted packet/transaction-

location area (FA_{pt}) when the terminal (t_1, t_2, t) and the network (n) enter a packet mode or a transaction mode.

24. Method according to claim 22 or 23, wherein the method includes the step to measure the duration of the active periods
5 in the communication between the terminal (t_1, t_2, t) and the network (n) and the duration of the silent periods in between these active periods to determine the type of communication.

25. Method according to claim 24, wherein the method further includes the step to enter the terminal (t_1, t_2, t) and the
10 network (n) in an initial mode when the terminal (t_1, t_2, t) logs on to the network (n).

26. Method according to claim 25, wherein the method includes the step to set the initial mode to be the session mode.

27. Method according to claim 25 or 26, wherein the method
15 includes the step to enter the terminal (t_1, t_2, t) and the network (n) in the session mode when the duration of an active period in the communication between the terminal (t_1, t_2, t) and the network (n) is long lasting.

28. Method according to claim 27, wherein the method includes
20 the step to enter the terminal (t_1, t_2, t) and the network (n) in the packet mode when the duration of an active period in the communication between the terminal (t_1, t_2, t) and the network (n) is very short lasting.

29. Method according to claim 28, wherein the method includes
25 the step to enter the terminal (t_1, t_2, t) and the network (n) in the transaction mode when the duration of an active period in the communication between the terminal (t_1, t_2, t) and the network (n) is medium lasting.

30. Method according to claim 28, wherein the method includes
30 the step to enter the terminal (t_1, t_2, t) and the network (n) in the transaction mode when the duration of a silent period in

the communication between the terminal (t_1 , t_2 , t) and the network (n) exceeds a threshold value (T_p).

31. Method according to claim 29, wherein the method includes the step to enter the terminal (t_1 , t_2 , t) and the network (n) in the session mode when the duration of a silent period in the communication between the terminal (t_1 , t_2 , t) and the network (n) exceeds a threshold value (T_t).

32. Method according to any of the claims 22-31, wherein the method includes the step to simultaneously collect and store data in the terminal (t_1 , t_2 , t) and in the network (n) at every contact between the terminal (t_1 , t_2 , t) and the network (n), wherein the data comprise information about the position of the terminal (t_1 , t_2 , t) in the network (n), the speed of the terminal (t_1 , t_2 , t) and the direction of the terminal (t_1 , t_2 , t) in the network (n).

33. Method according to claim 32, wherein the method includes the step to base the long term adapted location area (HA_{t1} , HA_{t2}) on the mentioned data, which long term adapted location area (HA_{t1} , HA_{t2}) is created by the terminal (t_1 , t_2 , t) and transferred to the network (n) at the initial contact between the terminal (t_1 , t_2 , t) and the network (n), when the terminal (t_1 , t_2 , t) logs on to the network (n).

34. Method according to claim 33, wherein the method includes the step to let the terminal (t_1 , t_2 , t) periodically create a new long term adapted location area (HA_{t1} , HA_{t2}) and transfer the definition of the mentioned new long term adapted location area (HA_{t1} , HA_{t2}) to the network (n) if the terminal (t_1 , t_2 , t) remains logged on to the network (n) for a long time.

35. Method according to claim 33 or 34, wherein the method includes the step to create a new short term adapted session-location area (FA_s) by the terminal (t_1 , t_2 , t) and the network (n) at every contact between the terminal (t_1 , t_2 , t) and the

network (n) or when the terminal (t_1, t_2, t) reaches a border of a current short term adapted session-location area (FA_s), if the terminal (t_1, t_2, t) is located in the current short term adapted session-location area (FA_s).

5 36. Method according to any of the claims 23-31, wherein the method includes the step to simultaneously collect and store data in the terminal (t_1, t_2, t) and in the network (n) at every contact between the terminal (t_1, t_2, t) and the network (n), wherein the data comprise information about the position of the
10 terminal (t_1, t_2, t) in the network (n), the speed of the terminal (t_1, t_2, t) and the direction of the terminal (t_1, t_2, t) in the network (n).

37. Method according to claim 36, wherein the method includes the steps to create a new short term adapted packet/transaction-
15 location area (FA_{pt}) by the terminal (t_1, t_2, t) and the network (n) at every contact between the terminal (t_1, t_2, t) and the network (n) if the terminal (t_1, t_2, t) is located in a current short term adapted packet/transaction-location area (FA_{pt}), and to use a momentary short term adapted packet/transaction-
20 location area (FA_{pt}) by the terminal (t_1, t_2, t) when the terminal (t_1, t_2, t) enters a new cell in the network (n) or by the network (n) when the network (n) has to page the terminal (t_1, t_2, t) in the network (n), if the terminal (t_1, t_2, t) is located in the current short term adapted packet/transaction-
25 location area (FA_{pt}).

38. Method according to claim 35 or 37, wherein the creation of the short term adapted session-location area (FA_s) and the short term adapted packet/transaction-location area (FA_{pt}) uses a radius (R_G) and focal points (r_p), wherein the radius (R_G)
30 determine the size of the mentioned location areas and the focal points (r_p) determine the shape and the position of the mentioned location areas.

39. Method according to claim 38, wherein the short term adapted session-location area (FA_s) and the short term adapted packet/transaction-location area (FA_{pt}) are created without any transfer of data between the terminal (t_1, t_2, t) and the
5 network (n).

40. Method according to claim 39, wherein the short term adapted packet/transaction-location area (FA_{pt}) changes continuously with time.

41. Method according to any of the claims 22-40, wherein the
10 method includes the step to let the home area be an area constituting the normal mobility pattern of the movements of the terminal (t_1, t_2, t) in the network (n) based on long term statistics of the movements of the terminal (t_1, t_2, t) in the network (n).

15 42. Method according to any of the claims 20-41, wherein the method includes the step to let the network (n) be a universal network (GRAN, Generic Radio Access Network).

43. Apparatus in a communication network (n) comprising cells (C_1-C_3) and basestations (BS_1-BS_9), which apparatus is able to
20 communicate with the network (n) with a type of communication, determined by the duration of the active periods in the communication and the duration of the silent periods in between these active periods, wherein an adapted location area is created for the apparatus depending on the type of communication
25 between the apparatus and the network (n), which apparatus comprises

receiver means (303) for receiving signals from the network (n);

transmitter means (305) for transmitting signals to
30 the network (n);

input means (307) for registering when the apparatus logs on to the network (n), wherein the apparatus is set in an initial mode;

5 timer means (309) for triggering the apparatus to enter a suitable mode when the duration of a silent period in the communication between the apparatus and the network (n) exceeds a predefined threshold value (T_p , T_t);

measuring means (313) for measuring the duration of the active periods in the communication and the duration of the
10 silent periods in between these active periods;

memory means (315) for storing data collected by the apparatus at every contact between the apparatus and the network (n);

calculating means (317) for creating suitable
15 location areas for the apparatus using the data stored in the memory means (315), wherein

a long term adapted location area (HA_{t1} , HA_{t2}), adapted to the long term mobility pattern of a user of the apparatus, is created when the apparatus is located in a home area and when
20 the apparatus and the network (n) is set in a session mode,

a short term adapted session-location area (FA_s) is created when the apparatus is located outside the home area and when the apparatus and the network (n) is set in the session mode, and

a short term adapted packet/transaction-location area (FA_{pt})
25 is created when the apparatus and the network (n) is set in a packet mode or a transaction mode; and

control means (319) for controlling said means.

44. Apparatus according to claim 43, wherein the initial mode is equal to the session mode.

45. Apparatus according to claim 43 or 44, wherein said data comprise information about the position of the apparatus in the network (n), the speed of the apparatus and the direction of the apparatus in the network (n).

5 46. Apparatus according to claim 45, wherein the apparatus is set in the session mode when the duration of an active period in the communication between the apparatus and the network (n) is long lasting.

10 47. Apparatus according to claim 46, wherein the apparatus is set in the packet mode when the duration of an active period in the communication between the apparatus and the network (n) is very short lasting.

15 48. Apparatus according to claim 47, wherein the apparatus is set in the transaction mode when the duration of an active period in the communication between the apparatus and the network (n) is medium lasting.

20 49. Apparatus according to claim 48, wherein the long term adapted location area (HA_{t1} , HA_{t2}) is created and transferred to the network (n) at the initial contact between the apparatus and the network (n), when the apparatus logs on to the network (n).

25 50. Apparatus according to claim 49, wherein the size of the short term adapted session-location area (FA_s) and the short term adapted packet/transaction-location area (FA_{pt}) is determined by a radius (R_G), and the shape and the position of the mentioned location areas are determined by focal points (r_p).

30 51. Apparatus according to any of the claims 43-50, wherein the home area is an area constituting the normal mobility pattern of the movements of the apparatus in the network (n) based on long term statistics of the movements of the apparatus in the network (n).

52. Apparatus according to any of the claims 43-51, wherein the network (n) is a universal network (GRAN, Generic Radio Access Network).

1/6

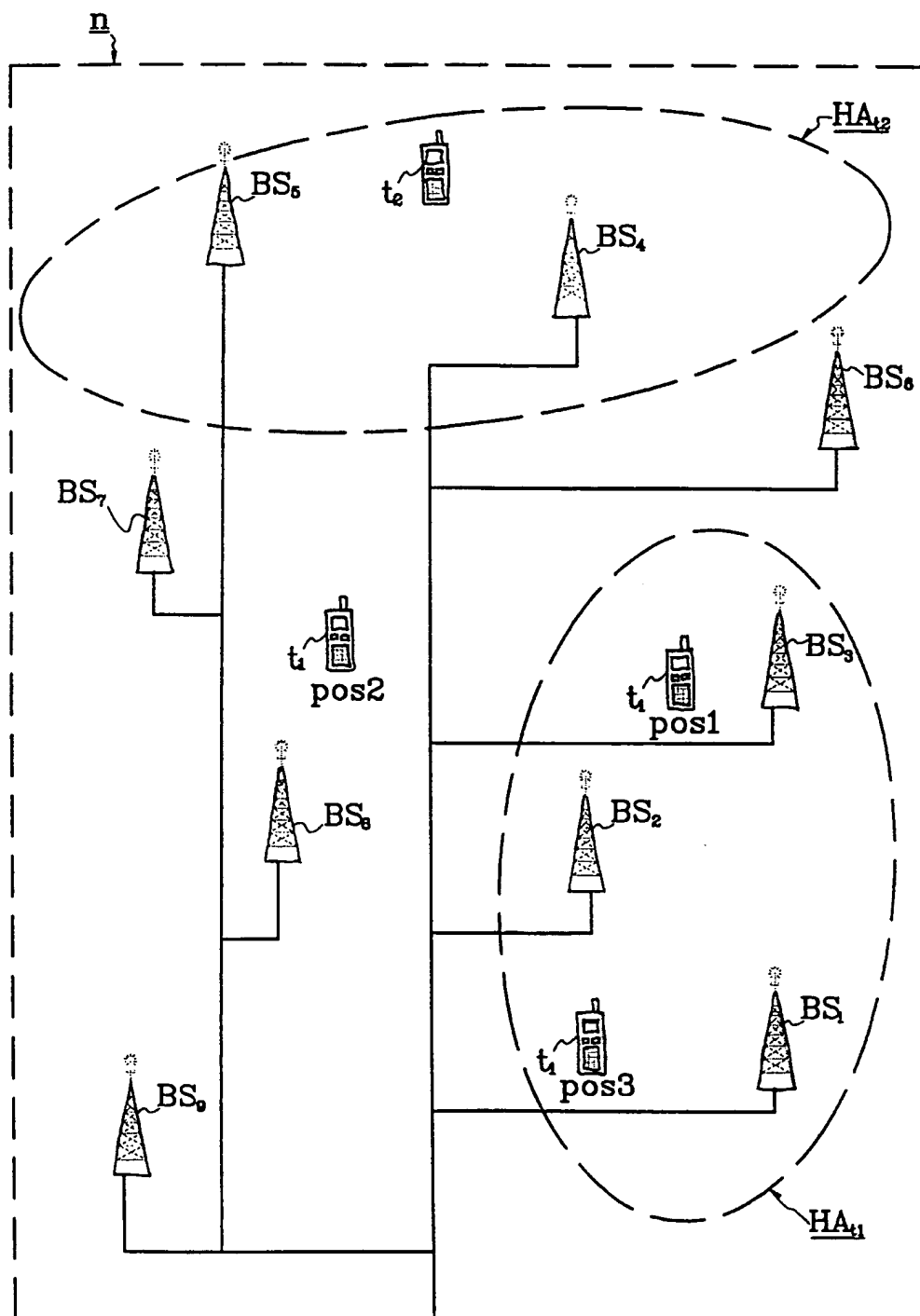


Fig.1

2/6

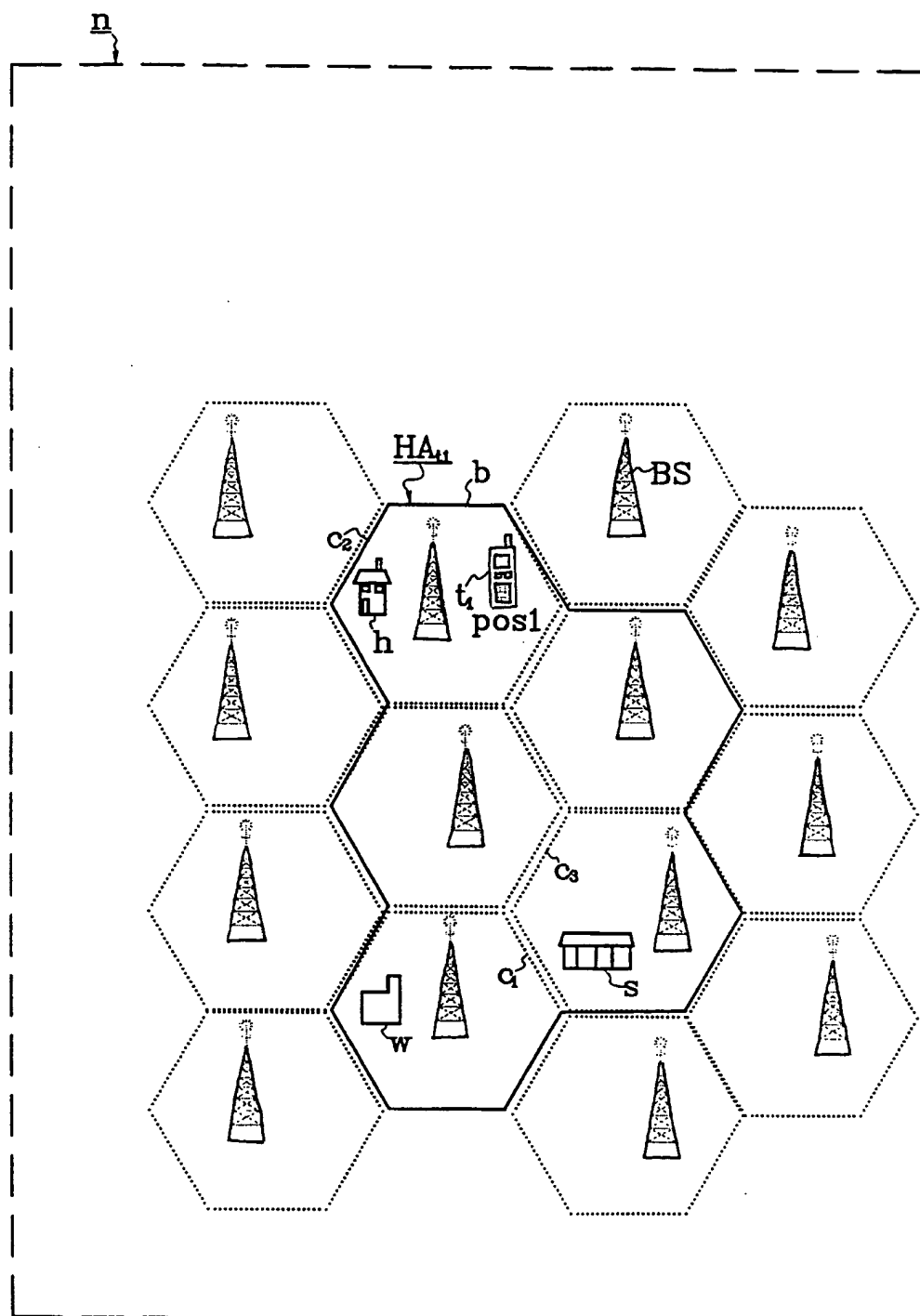


Fig.2

3/6

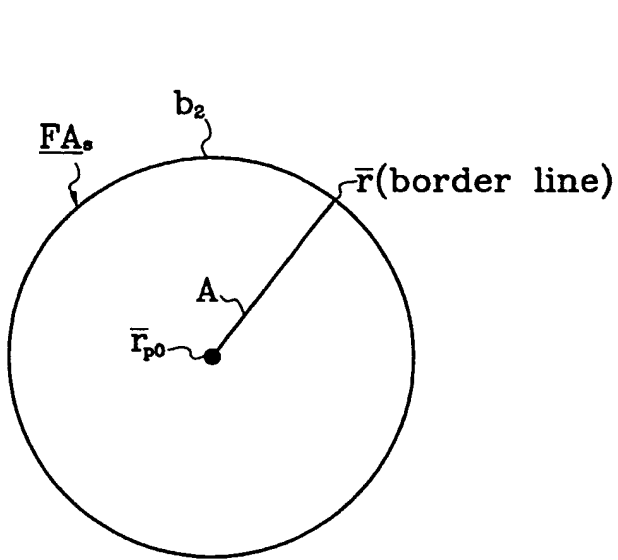


Fig.3a

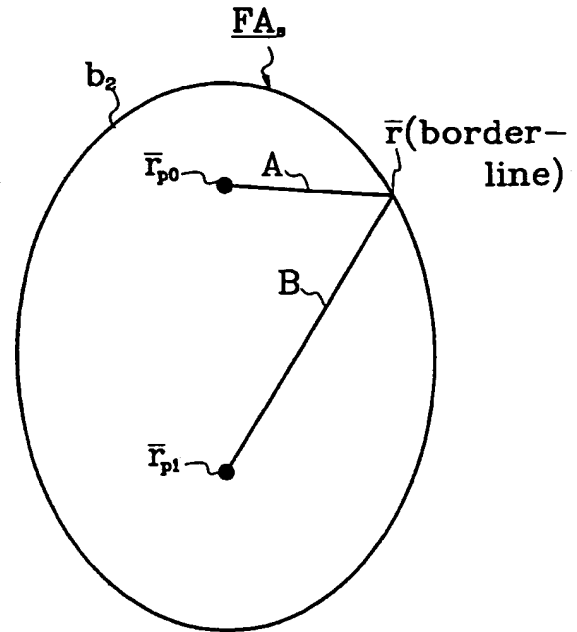


Fig.3b

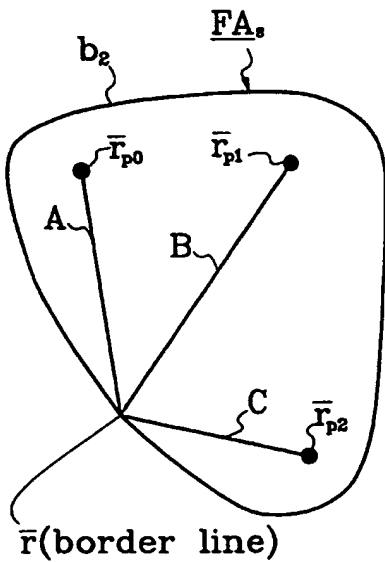


Fig.3c

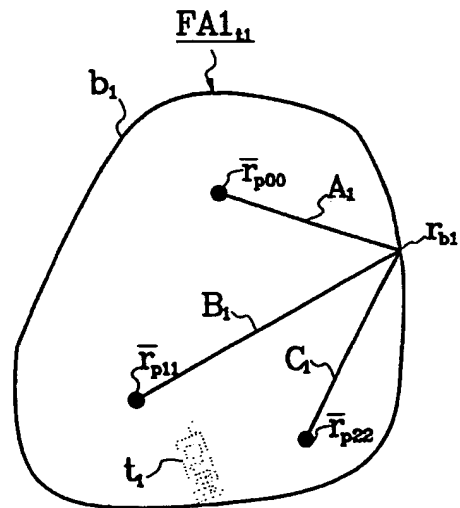
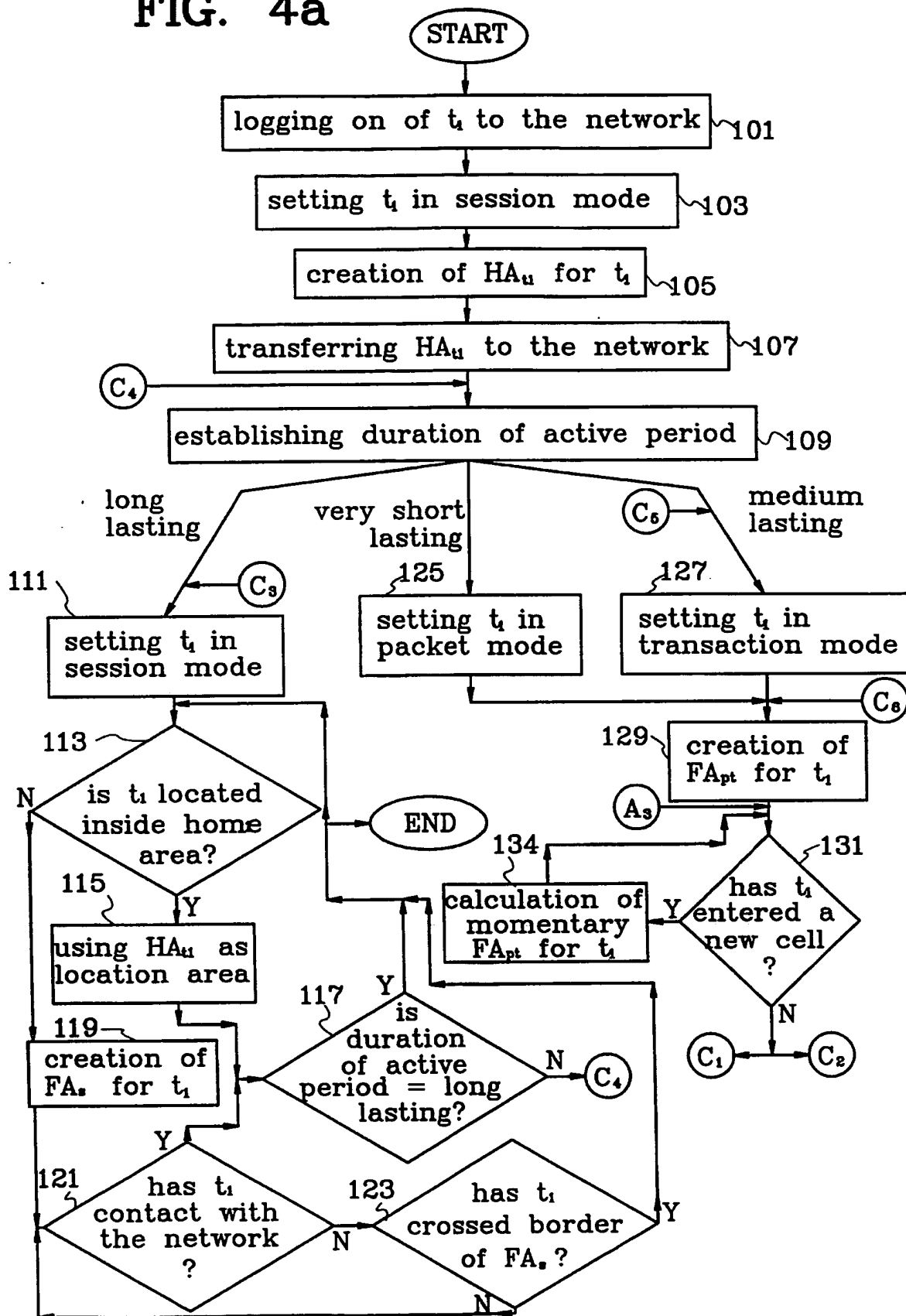


Fig.3d

4/6
FIG. 4a



5/6

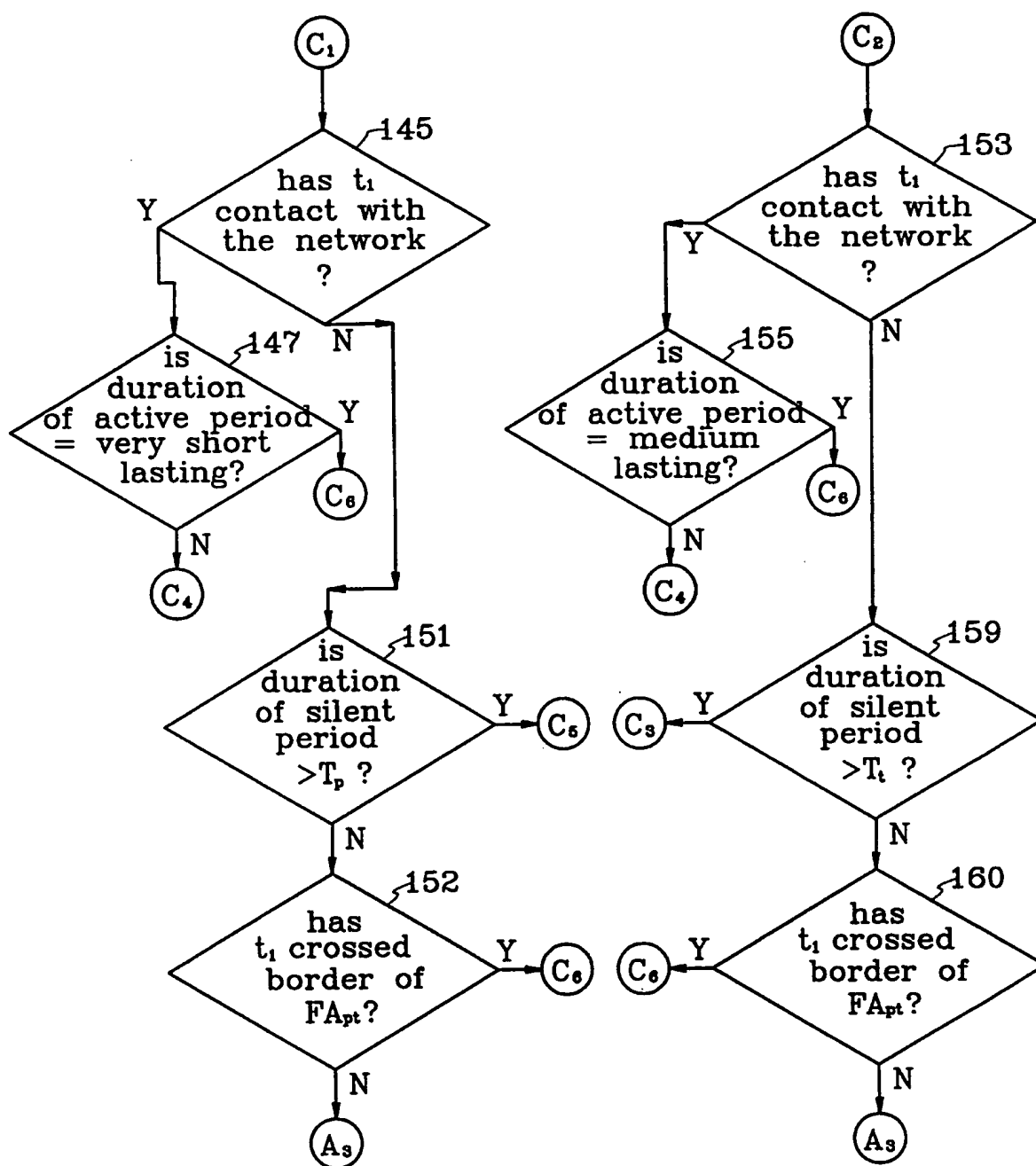


FIG. 4b

6/6

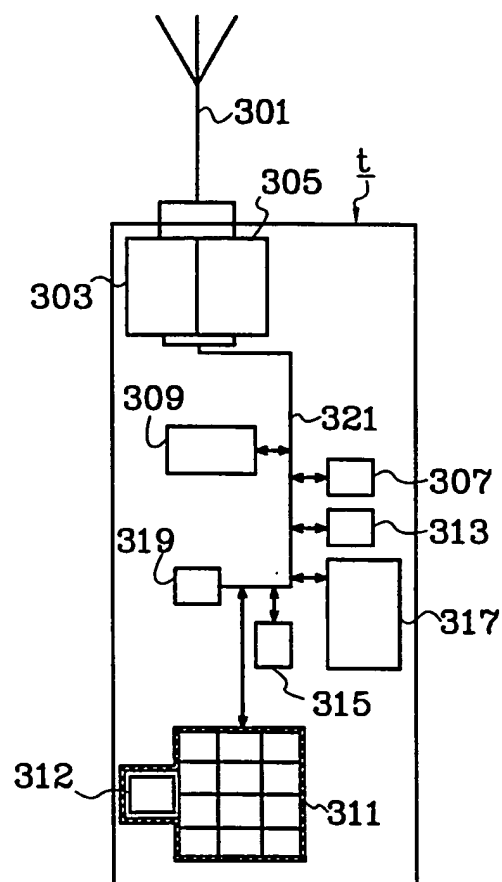


FIG. 5

INTERNATIONAL SEARCH REPORT

International Application No

PCT/SE 99/00775

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q7/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	WO 95 28063 A (NOKIA TELECOMMUNICATIONS OY ;JOKIAHO TIMO (FI); RAJALA JUSSI (FI);) 19 October 1995 (1995-10-19) page 4, line 9 - line 26 page 5, line 15 -page 6, line 13 page 10, line 3 - line 14 page 11, line 32 -page 12, line 15 page 13, line 14 -page 14, line 12 page 20, line 14 - line 25 --- -/--	20,21,23 1,43

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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- "P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search

17 September 1999

Date of mailing of the international search report

08/10/1999

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/SE 99/00775

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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